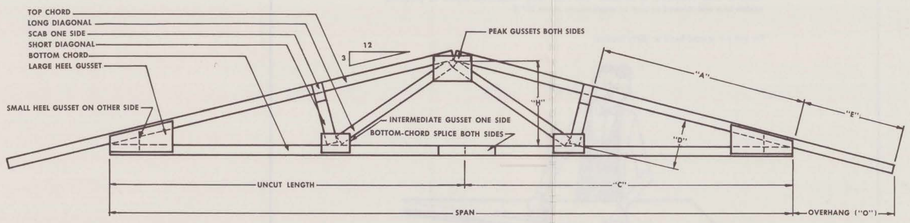
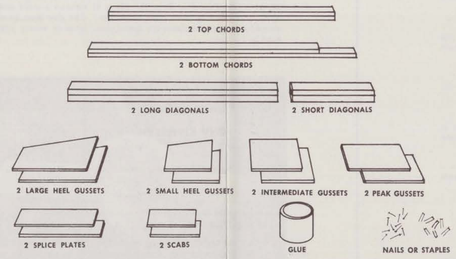
3/12 NAIL-GLUED ROOF TRUSS — 2′ ON CENTER, 20′-8″ TO 28′-8″ SPANS

TO BUILD THIS 3/12 TRUSS

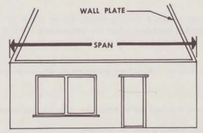


YOU WILL NEED THIS MATERIAL



1 MEASURE SPAN

Determine the span (out-to-out dimension of exterior wall plates) and also the amount of overhang desired.



2 ORDER MATERIAL

From the order schedule below, determine the size of pieces needed.
Example: A span of 24′-8″ requires one 2″ x 4″ x 12′ and one 2″ x 4″ x 14′ for the bottom chords.

ORDER SCHEDULE

SPAN	20′ 8″	21′ 0″	21′ 4″	21′ 8″	22′ 0″	22′ 4″	22′ 8″	23′ 0″	23′ 4″	23′ 8″	24′ 0″	24′ 4″	24′ 8″	25′ 0″	25′ 4″	25′ 8″	26′ 0″	26′ 4″	26′ 8″	27′ 0″	27′ 4″	27′ 8″	28′ 0″	28′ 4″	28′ 8″
TWO TOP CHORDS*†	Two 2″ x 4″ x 14′				Two 2″ x 4″ x 16′						Two 2″ x 4″ x 18′														
TWO BOTTOM CHORDS†	One 2″ x 4″ x 10′ One 2″ x 4″ x 12′			Two 2″ x 4″ x 12′				One 2″ x 4″ x 12′ One 2″ x 4″ x 14′			Two 2″ x 4″ x 14′					One 2″ x 4″ x 14′ One 2″ x 4″ x 16′									
TWO LONG DIAGONALS TWO SHORT DIAGONALS	Two 2″ x 4″ x 8′																					Two 2″ x 4″ x 10′			
GUSSETS	½″ x 4′ x 8′ Plywood — structural interior**																								
GLUE	1 lb. Casein Glue, Federal Specification MMM-A-125, Type I or Type II***																								
FASTENERS	184 4d nails or 1 ⅛″ staples																								

* Provides the amount of overhang "O" shown on the cutting schedule. If greater overhang is desired, order longer top chords.
† Use "1500f" stress grade. Apply grading provisions to entire length of piece. Moisture content of lumber should be between 12 and 18 per cent.
** Plywood fabricated with exterior-type glue is recommended for use in humid areas.
*** Type II contains a mold inhibitor, which is desirable. In humid areas or for exposed construction, use a "waterproof adhesive."

3 CUT MEMBERS ACCORDING TO THIS SCHEDULE (Cut one pattern truss first.)

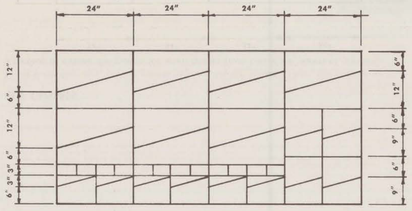
CUTTING SCHEDULE

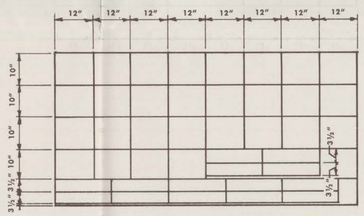
SPAN		20′ 8″	21′ 0″	21′ 4″	21′ 8″	22′ 0″	22′ 4″	22′ 8″	23′ 0″	23′ 4″	23′ 8″	24′ 0″	24′ 4″	24′ 8″	25′ 0″	25′ 4″	25′ 8″	26′ 0″	26′ 4″	26′ 8″	27′ 0″	27′ 4″	27′ 8″	28′ 0″	28′ 4″	28′ 8″
BOTTOM CHORDS	Uncut Member	10′-0″				12′-0″															14′-0″					
	Member "C"	10′-8″	11′-0″	11′-4″	11′-8″	12′-0″	10′-4″	10′-8″	11′-0″	11′-4″	11′-8″	12′-0″	12′-4″	12′-8″	13′-0″	13′-4″	13′-8″	14′-0″	12′-4″	12′-8″	13′-0″	13′-4″	13′-8″	14′-0″	14′-4″	14′-8″
TOP CHORDS		Cut Top Chords Only If Less Overhang Than That Listed in Item "O" Is Desired.																								
SHORT DIAGONAL*	"D"	19″			20″			21″			22″			23″			24″			25″			26″		27″
LONG DIAGONAL		Use Material Left After Cutting Short Diagonals																								
HEIGHT (Inside Dimension)	"H"	31″	31 ½″	32″	32 ½″	33″	33 ½″	34″	34 ½″	35″	35 ½″	36″	36 ½″	37″	37 ½″	38″	38 ½″	39″	39 ½″	40″	40 ½″	41″	41 ½″	42″	42 ½″	43″
EXTENSION†	"E"	40 ⅛″	38 ⅛″	36″	34″	32″	29 ⅞″	27 ¾″	25 ¾″	47 ⅝″	45 ⅝″	43 ½″	41 ½″	39 ⅜″	37 ⅜″	35 ¼″	33 ¼″	31 ¼″	29 ⅛″	27″	25″	47″	44 ⅞″	42 ⅝″	40 ¾″	38 ¾″
OVERHANG†	"O"	39″	37″	35″	33″	31″	29″	27″	25″	46 ¼″	44 ¼″	42 ¼″	40 ¼″	38 ¼″	36 ¼″	34 ¼″	32 ¼″	30 ¼″	28 ¼″	26 ¼″	24 ¼″	45 ½″	43 ½″	41 ½″	39 ½″	37 ½″
DIMENSION "A"		6′-4″			6′-8″			7′-0″			7′-4″			7′-8″			8′-0″			8′-4″			8′-8″		9′-0″

* Cut one short diagonal from each piece of 2″ x 4″ ordered for diagonals.
† If top chords are purchased in accordance with Order Schedule, these dimensions result. However, overhangs greater than 26 inches require additional support.

4 CUT GUSSETS

Using these diagrams, cut the gussets required for the trusses. These diagrams show a method of cutting the gussets for seven trusses from two 4′ x 8′ sheets of plywood.



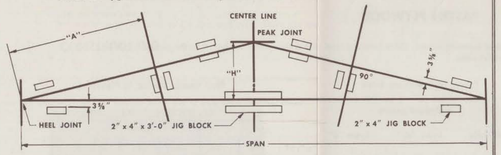


5 CONSTRUCT JIG

Lay out a chalk line equal to the span and draw center line through it. Mark off dimension "H" on center line.

Lay out top-chord chalk lines from peak to heel joints. Divide these lines with perpendicular lines at dimension "A" (Dimensions "H" and "A" for the different spans are given in the Cutting Schedule, Figure 3.)

Nail 2″ x 4″ jig blocks as shown on diagram.

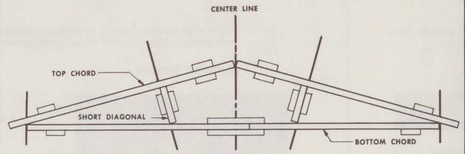


6 START PATTERN

Put top and bottom chords into position. Top chords should meet at center line. If either member of the bottom chord is warped, it should be placed with crown up.

Cut the extension of the top chord to obtain the desired overhang.

Lay the short diagonals into place.

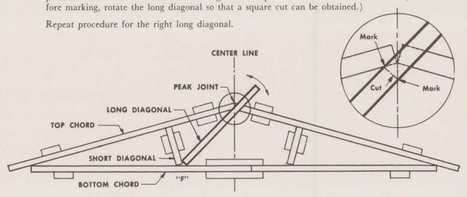


7 CUT LONG DIAGONAL

To make the long diagonal, take one of the two remaining 2″ x 4″'s. Place one end against both the bottom chord and the short diagonal at their intersection ("F").

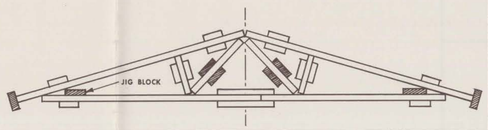
Lay the other end of the long diagonal over the peak joint. Mark on the long diagonal the point at which it intersects the bottom edge of the top chord and also the center line. (Before marking, rotate the long diagonal so that a square cut can be obtained.)

Repeat procedure for the right long diagonal.



8 COMPLETE JIG AND PATTERN

Nail 8 more 2″ x 4″ jig blocks into place as shown. This completes the jig and the truss is ready for gluing and nailing.



9 CHECK PATTERN TRUSS

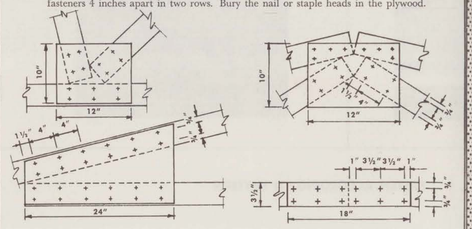
- Recheck alignment on all members. Be sure all members touch at the joints. Place additional jig blocks as needed.
- Check placement of gussets on truss. Make sure their edges do not extend beyond the top and bottom chords in such a way as to interfere with roof sheathing or ceiling material.

ASSEMBLE TRUSSES

- Use members of first truss as a pattern to cut members of all trusses to be built.
- Assemble trusses, using the jig.
- Place all gussets on the truss as shown. Mark around their outside edges, remove, and apply glue within the areas of the gussets.
- Nail or staple gussets, scabs, and splice plate as shown in Block 10. Remove from jig and turn truss over. Glue and fasten the 3 gussets and splice plate on the other side.
- Stack the completed trusses. Let glue set for prescribed curing period before handling the trusses.

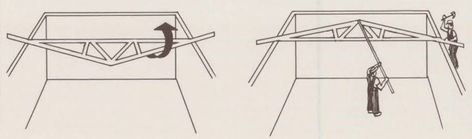
10 FASTEN GUSSETS

Use 4*d* nails or 1⅛″ staples for fastening gussets, scabs, and splice plates. Space fasteners 4 inches apart in two rows. Bury the nail or staple heads in the plywood.



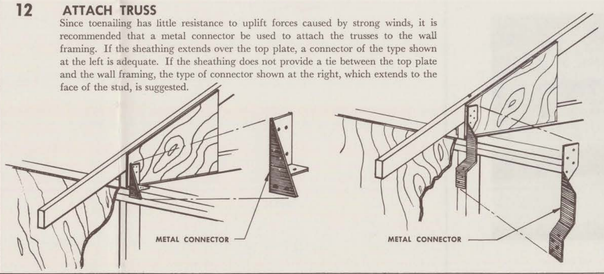
11 ERECT TRUSS

To erect the truss, place it in an inverted position with the ends resting on the wall plates. Swing the truss into position with a pole.



12 ATTACH TRUSS

Since toenailing has little resistance to uplift forces caused by strong winds, it is recommended that a metal connector be used to attach the trusses to the wall framing. If the sheathing extends over the top plate, a connector of the type shown at the left is adequate. If the sheathing does not provide a tie between the top plate and the wall framing, the type of connector shown at the right, which extends to the face of the stud, is suggested.



MATERIALS AND NAIL-GLUING

The quality of material and workmanship is important to the ultimate strength of the truss. Good judgment in the selection of materials must be used and the simple rules for nail-gluing and truss handling, as set forth in Small Homes Council Instruction Sheet #1, *Nail-Gluing of Roof Trusses and Frames and Other Structural Components*, must be followed.

- Use unsanded plywood, ½″ thick. It should be of a structural interior type, but for humid areas the plywood should be fabricated with exterior glue. The plywood must meet Commercial Standard CS45-60 as certified by an approved testing laboratory. (A modified design with larger gusset plate sizes permits the use of ⅜″ plywood; — see Instruction Sheet #13.)
- Use 4*d* common nails or 1⅛″ staples for nail-gluing the plywood plates. The fasteners should be spaced no farther than 4″ o.c. in two rows and ¾″ from the edges.
- The casein glue must meet Federal Specification MMM-A-125, Type I or II. (Type II is preferred since it contains a mold inhibitor.)

A phenol-resorcinol adhesive (Federal Specification MIL-A-397B) is acceptable if a waterproof glue is desired. Mix the glue according to the manufacturers instructions. After nailing, stack the trusses and do not handle them during the curing period. Protect the trusses from rain.

- The major chords of the truss should be fabricated with "1500f" stress-rated (rated by visual inspection or machine) 2 x 4 members. The interior members (the long and short diagonals), should be of material rated as "Construction Grade" by grading rules of the West Coast Lumber Inspection Bureau (WCLB) or the Western Pine Association (WPA), or "No. 2 Dimension" by the Southern Pine Inspection Bureau (SPIB) or equivalent in other grading rules. In all cases, the moisture content of the lumber should be from 12 to 18 per cent.
- Fabricate and cure the trusses above 50° F. When the temperature is between 50° F and 70° F, a 16-hour curing period is necessary; when the temperature is 70° F or above, an 8-hour curing period is needed. A minimum curing temperature of 70° F is required for waterproof glues.

DESIGN AND PERFORMANCE DATA FOR 3/12 NAIL-GLUED ROOF TRUSS

STRUCTURAL DESIGN DATA

The graphical methods of analysis are unreliable in calculating stresses in the nail-glued truss. They do not consider the combined stresses due to secondary bending caused by the extreme rigidity of the nail-glued joint. The "W" nail-glued truss designs are based upon full-scale test results. Three types of test were performed: load-and-recovery; long-duration at design load; and load-to-destruction.

For the *load-and-recovery test*, two trusses were set up in the normal position, 24 inches on center, and covered with ⅜-inch plywood sheathing with the grain of the outer plies perpendicular to the truss chords and with sections spaced so the sheathing did not touch adjacent sheets. Loads were applied by means of concrete blocks placed so as to avoid arching action.

An initial load of 10 pounds per square foot, representing the dead load, was applied before beginning deflection readings. Live loads were applied in increments of 10 pounds per square foot and deflection readings were taken along the bottom chords of the trusses. After each increment was applied, the entire live load was removed and the residual deflections recorded. After removal of the design live load of 30 pounds per square foot, the residual deflection averaged 0.015 inches. The loads were increased until a live load of 100 pounds per square foot was recorded.

For the *long-duration test*, the pair of trusses was loaded with 10 pounds per square foot dead load and 30 pounds per square foot live load (considered the design load). The trusses supported this load for 60 days without failure.

For the *load-to-destruction test*, load was added to the trusses after completion of the long-duration test until failure occurred at a loading of 142 pounds per square foot. Failure appeared to have occurred in the top chord between the peak gusset and the intermediate compression member. No glue-line connection failures were observed.

DESIGN DATA

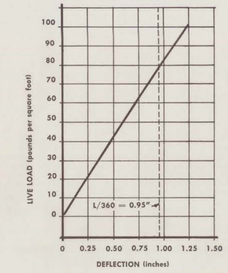
Span: 20′-8″ to 28′-8″
Slope: 3/12

Dead Load	10 psf.
Live Load	30 psf.
Total	40 psf.

ACTUAL TEST DATA

(average of 2 trusses)

Deflection at 30 psf. live load	0.29″
Average residual set after release of 30 psf.	0.015″
Average residual set after release of 100 psf.	0.035″
TOTAL LOAD at Failure	142 psf.

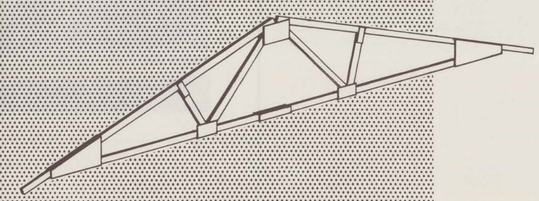


NAIL-GLUED "W" ROOF TRUSS

2 x 4 MEMBERS 3/12 SLOPE

2′ on Center, 20′-8″ to 28′-8″ Spans

INSTRUCTION SHEET #3



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University of Illinois

Revisions 1964 by Rudard A. Jones, registered architect, and Donald H. Percival, wood technologist, University of Illinois Small Homes Council–Building Research Council

The original data and plans result from a research study conducted jointly by the Wood Research Laboratory at Purdue University, Lafayette, Indiana, and the Small Homes Council at the University of Illinois at Urbana, Illinois.

PRICE: 50 CENTS

A.I.A. 19 B 3

NAIL-GLUING OF ROOF TRUSSES, FRAMES AND OTHER STRUCTURAL COMPONENTS

1 NAIL-GLUE FOR STRENGTH AND ECONOMY

- Nail-gluing makes possible roof trusses, frames, and other structural components which are very stiff and strong. A glued joint holds two members firmly without slippage.
- In nail-gluing, the adhesive is applied to the structural members and nails or staples are used only to give rigidity to the unit during handling and stacking and to provide pressure while the glue sets. The strength of the finished connection is entirely dependent on the glue bond. Moisture content of lumber for the trusses and frames must be 19% or less.
- The casein glue must meet Federal Specification MMM-A-125, Type I or II. (Type II contains a mold inhibitor.) Mix the glue according to the manufacturer's instructions. Protect the units from rain. After nailing, stack and do not handle again during the curing period.
- Fabricate and cure the units above 50° F. The lumber and plywood likewise should not be below 50° F for nail-gluing. When the temperature is between 50° F and 70° F, a 16-hour minimum curing period is necessary; when the temperature is 70° F or above an 8-hour minimum curing period is needed.
- Nail-gluing should be used only with properly engineered designs. Use designs presented in the Illinois-Purdue instruction sheets for nail-glued trusses and roof-frames.*

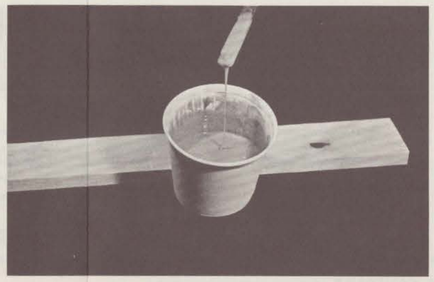
* **Design of Nail-Glued Plywood Gusset Plates,** Purdue University Agricultural Experiment Station, Bulletin 613, 1954, Lafayette, Indiana.

Instruction Sheets, University of Illinois Small Homes Council–Building Research Council, Urbana, Ill. (50¢ each)

#2 — 2/12 Nail-Glued "W" Roof Truss
#3 — 3/12 Nail-Glued "W" Roof Truss
#4 — 4/12 Nail-Glued "W" Roof Truss
#5 — Long-Span Nail-Glued "W" Roof Truss
#6 — 2" x 4" Nail-Glued King-Post Roof Truss
#7 — 2" x 6" Nail-Glued King-Post Roof Truss
#8 — Sloped Ceiling, Plywood Web Roof-Frames
#9 — Plywood Web Roof-Frame, 1/12 Slope
#10 — Hip-Roof Nail-Glued Trusses
#12 — Reselection of Lumber for Roof Trusses
#13 — Variations for Building Nail-Glued "W" Roof Truss
#21 — Nail-Glued Header for Wall Panels
#22 — Nail-Glued Headers for Larger Openings

2 MIX GLUE

Casein glue is recommended. The glue must meet Federal Specifications MMM-A-125, Type I or Type II. (Type II contains a mold inhibitor which is required by some local authorities.) The glue must be mixed according to the manufacturer's instructions. Thin or watery mixtures must be avoided.



3 LAY OUT STRUCTURAL COMPONENT

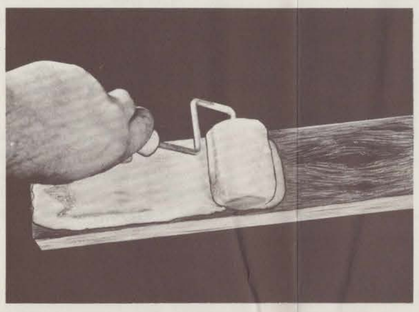
Lay out on a flat, sturdy surface (jig, subfloor or slab — not the ground) the truss, roof-frame or other component to be built. The units being constructed should be protected against rain and allowed to cure at temperatures above 50° F.

Do not use second-hand or dirty lumber.

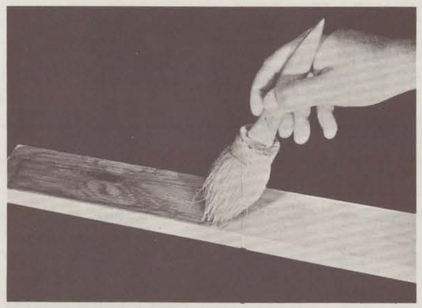
4 APPLY GLUE

Apply glue directly to the lumber members by means of a paint roller, glue brush or mechanical glue spreader.*

Paint Roller



Glue Brush



* For information and specifications for mechanical spreader, use "A Spreader for Use in Structural Nail-Gluing," Stanley K. Suddarth, Purdue University, Agricultural Experiment Station Circular 408, 1954, Lafayette, Indiana.

5 USE PLENTY OF GLUE

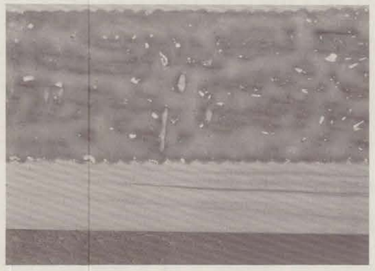
Use plenty of glue on the structural members to cover the entire area of contact. Glue need not be spread on gusset plates.

A correct spread of glue on the wood will look like that shown below.

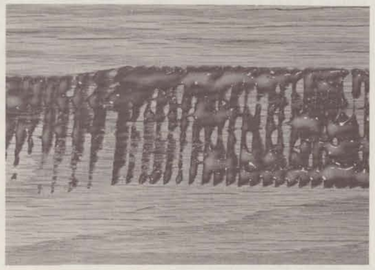
A glue spread which is too thin, such as shown in second photograph, will not give adequate glue bond.

A more than adequate glue spread, also illustrated, will result in a good glue bond but the practice is wasteful.

Correct Application



Inadequate Application



Wasteful Application

6 PUT PLYWOOD IN POSITION

After the glue has been applied to the lumber members, place the plywood in position on the glue area and fasten.

7 FASTEN PLYWOOD

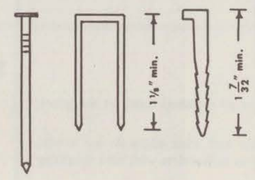
Nail or staple plywood preferably by means of a mechanical fastening device. Drive fasteners hard so that their heads are buried in the plywood. Solid-wood splice plates must be nailed manually with common wire nails.

Mechanical Fastening

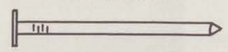
Types of Fasteners Used

For plywood gussets

4-d Nails **Type "A"** **Type "B"**



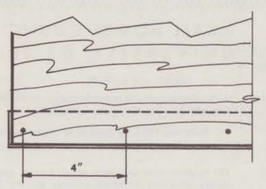
For solid splice plates



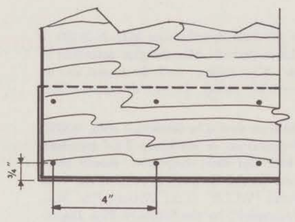
6-d Nails

Nail Heads Buried in Plywood

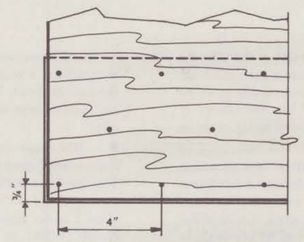
8 FASTEN ACCORDING TO PATTERN



For members 1⅜" wide use one row of fasteners spaced 4" apart.



For members 3⅜" wide, use two rows of fasteners spaced 4" apart.



For members 5½" wide use two rows of fasteners spaced 4" apart and stagger a third row down the center of the member.

9 JUDGE GLUE JOINT BY SQUEEZE-OUT

When two members are fastened together, some of the glue will be squeezed out if the correct amount of glue has been used. This is visual certification of a good glue joint.